Programming Principles in Python (CSCI 503/490)

Introduction

Dr. David Koop

Python Experience?

Programming Principles?

Why Python?

Productivity

Libraries, Libraries, Libraries

What about speed?

Why Principles?

Administrivia

- Course Web Site
- TA: Dalia Khaizaran
- Syllabus
  - Academic Integrity
  - Accommodations
- Assignments
- Tests: 2 (Feb. 18, Apr. 1) and Final (May 6)
- Course is offered to both undergraduates (CS 490) and graduates (CS 503)
  - Grad students have extra topics, exam questions, assignment tasks

Schedule

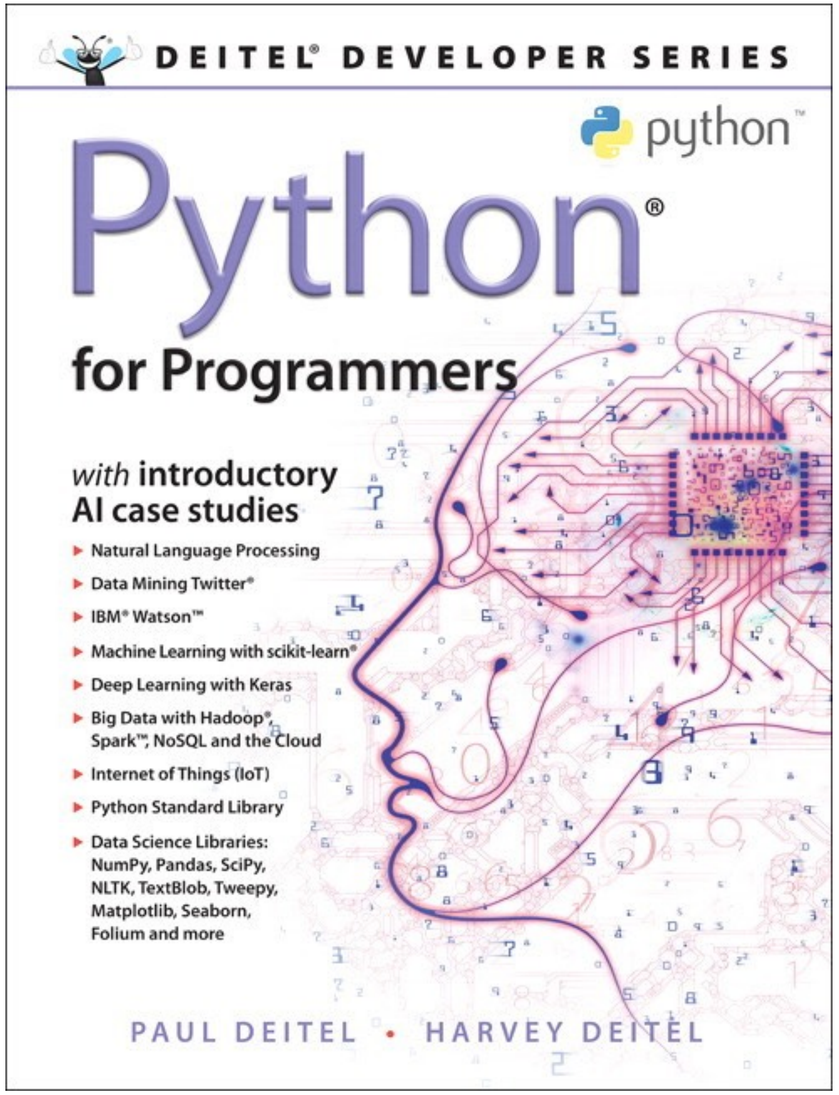
- Lectures are 9:30-10:45am MW in PM 203
  - Better for learning if you are engaged
  - **Ask questions**
  - Please advise me of any issues
  - Short quizzes may be given at the beginning of class
- Any changes will be announced as soon as possible
- Slides will be posted to the course website

Office Hours & Email

- TA office hours will be held in person in TA Offices (PM 362)
  - TuTh: 9:00am-12:00pm
- Prof. Koop's office hours will be held in person in PM 461
  - M: 1:45-3:00pm, W: 10:45am-12:00pm, or by appointment
  - You do not need an appointment to stop by during scheduled office hours,
  - If you wish to meet virtually, please schedule an appointment
  - If you need an appointment, please email me with **details** about what you wish to discuss and times that would work for you
- Many questions can be answered via email. **Please consider writing an email before scheduling a meeting.**

Course Material

- Textbook:
  - Recommended: Python for Programmers
  - Good overview + data science examples
- Many other resources are available:
  - https://wiki.python.org/moin/BeginnersGuide
  - https://wiki.python.org/moin/IntroductoryBooks
  - http://www.pythontutor.com
  - https://www.python-course.eu
  - https://software-carpentry.org/lessons/



Course Material

- Software:
  - Jupyter Notebook: Web-based interface for interactively writing & executing Python code
  - JupyterLab: An updated web-based interface that includes the notebook and other cool features
  - JupyterHub: Access everything through a server
  - Install using conda/mamba, pixi, uv

Online Students

- Same course material
- In-person lectures are recorded and shared online (same day)
- All deadlines are the same as for in-person students
- Quizzes conducted online
- Instructor and TA will be available for office hours online
- Exams will be conducted via Blackboard: Instructor may conduct them synchronously (Zoom/Teams) and/or using Respondus LockDown browser

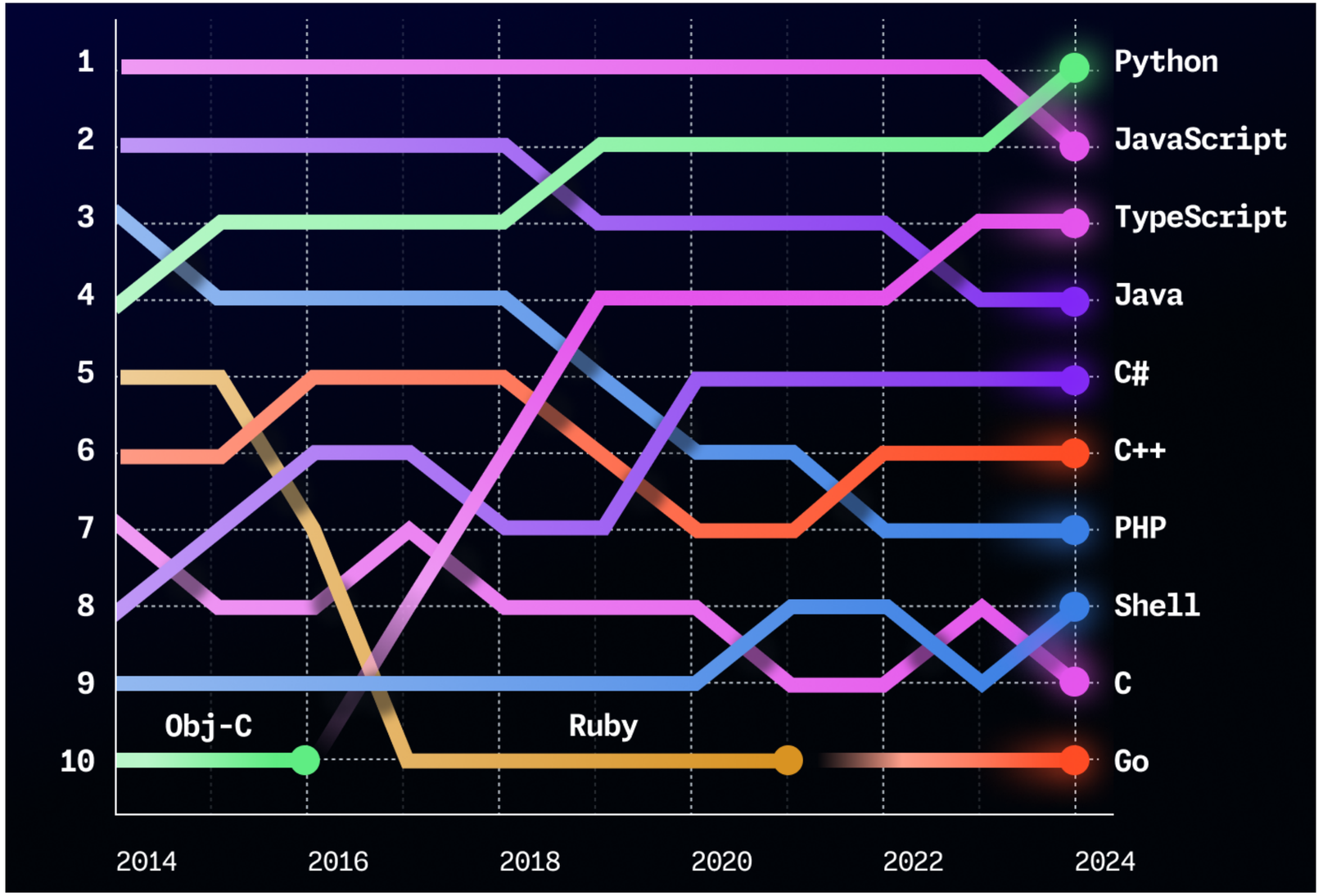
Academic Integrity

- **Do not cheat!**
- You will receive a **zero** for any assignment/exam/etc. where cheating has occurred
- You will **fail** the course if you cheat more than once
- Misconduct is **reported** through the university's system
- You **may** discuss problems and approaches with other students
- You **may not** copy or transcribe code from another source
- **Do not** use artificial intelligence solutions to write code

Python

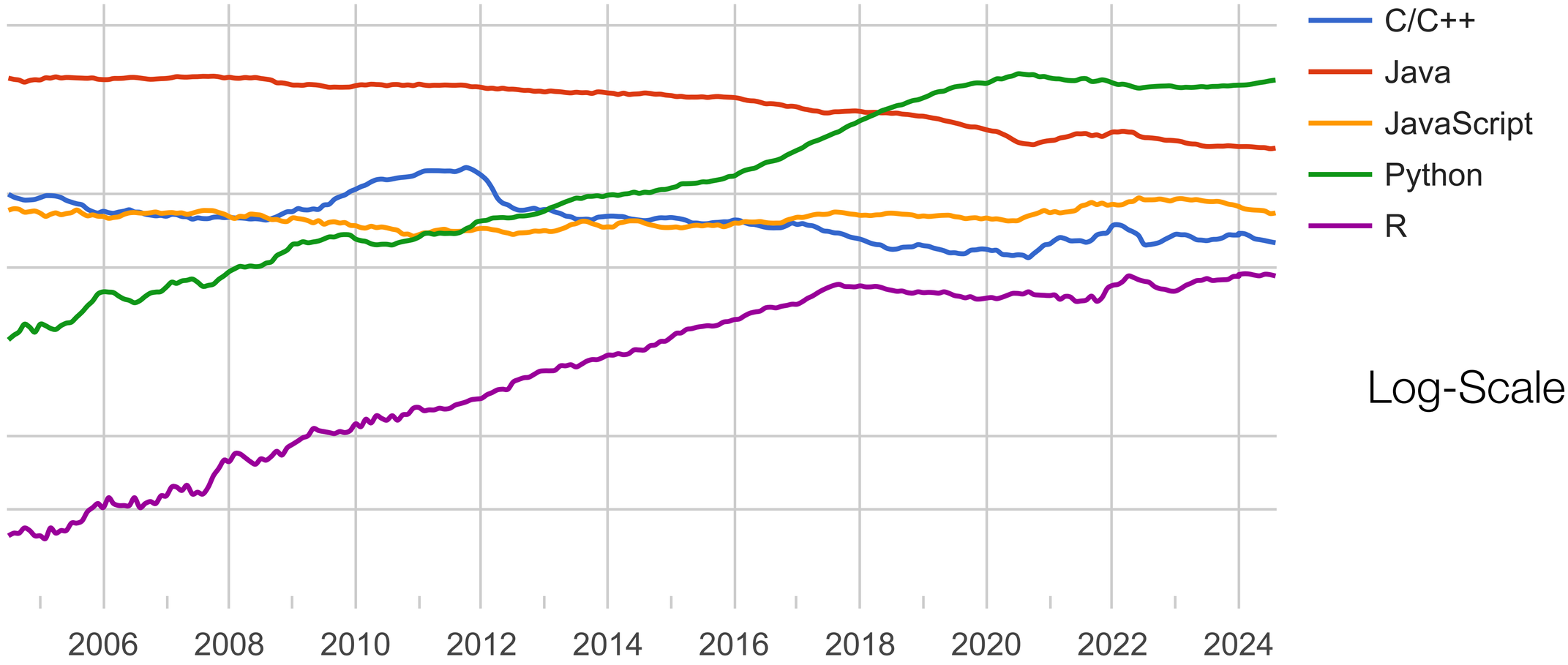
- Started in December 1989 by Guido van Rossum
- “Python has surpassed Java as the top language used to introduce U.S. students to programming…” (ComputerWorld, 2014)
- Python is also a top language for data science
- High-level, interpreted language
- Supports multiple paradigms (OOP, procedural, functional)
- Help programmers write **readable** code, use less code to do more
- Lots of libraries for python
- Designed to be extensible, easy to wrap code from other languages like C/C++
- Open-source with a large, passionate community

Python the #1 Programming Language in 2024



[GitHub]

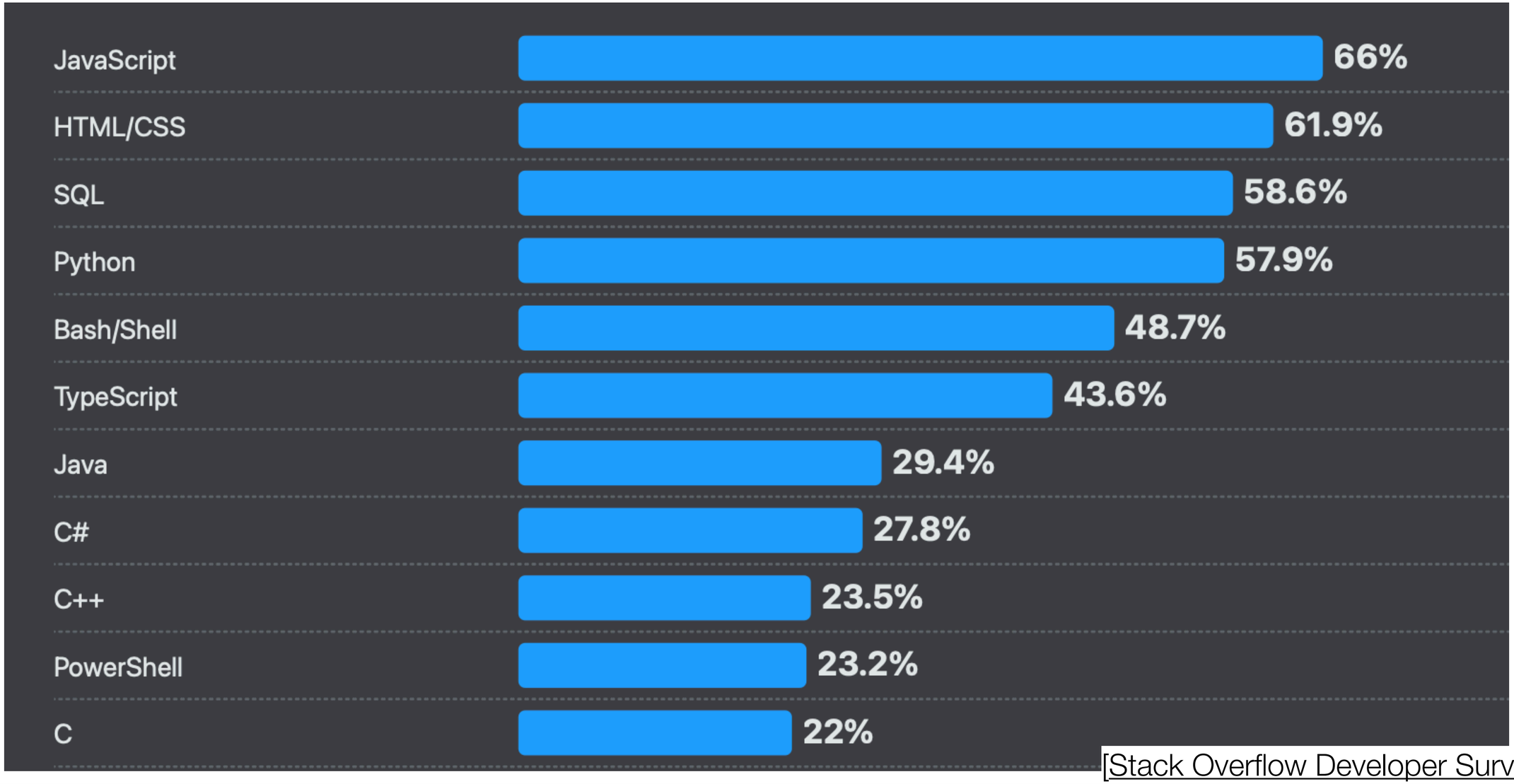
Even Wider Gap in Google Tutorial Searches



Log-Scale

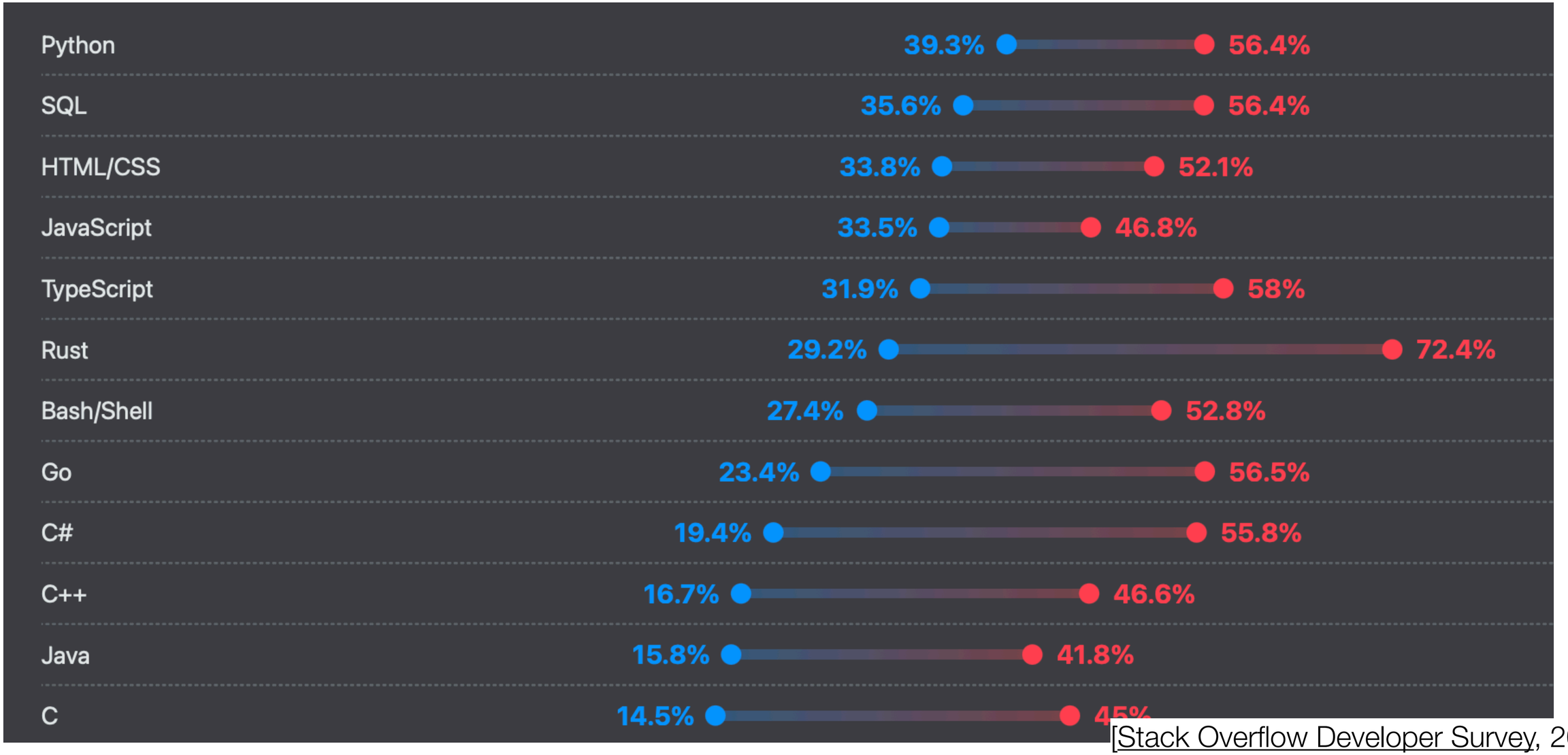
[PopularitY of Programming Language]

StackOverflow Language Usage



[Stack Overflow Developer Survey, 2025]

StackOverflow Admired and Desired



[Stack Overflow Developer Survey, 2025]

Modes of Computation

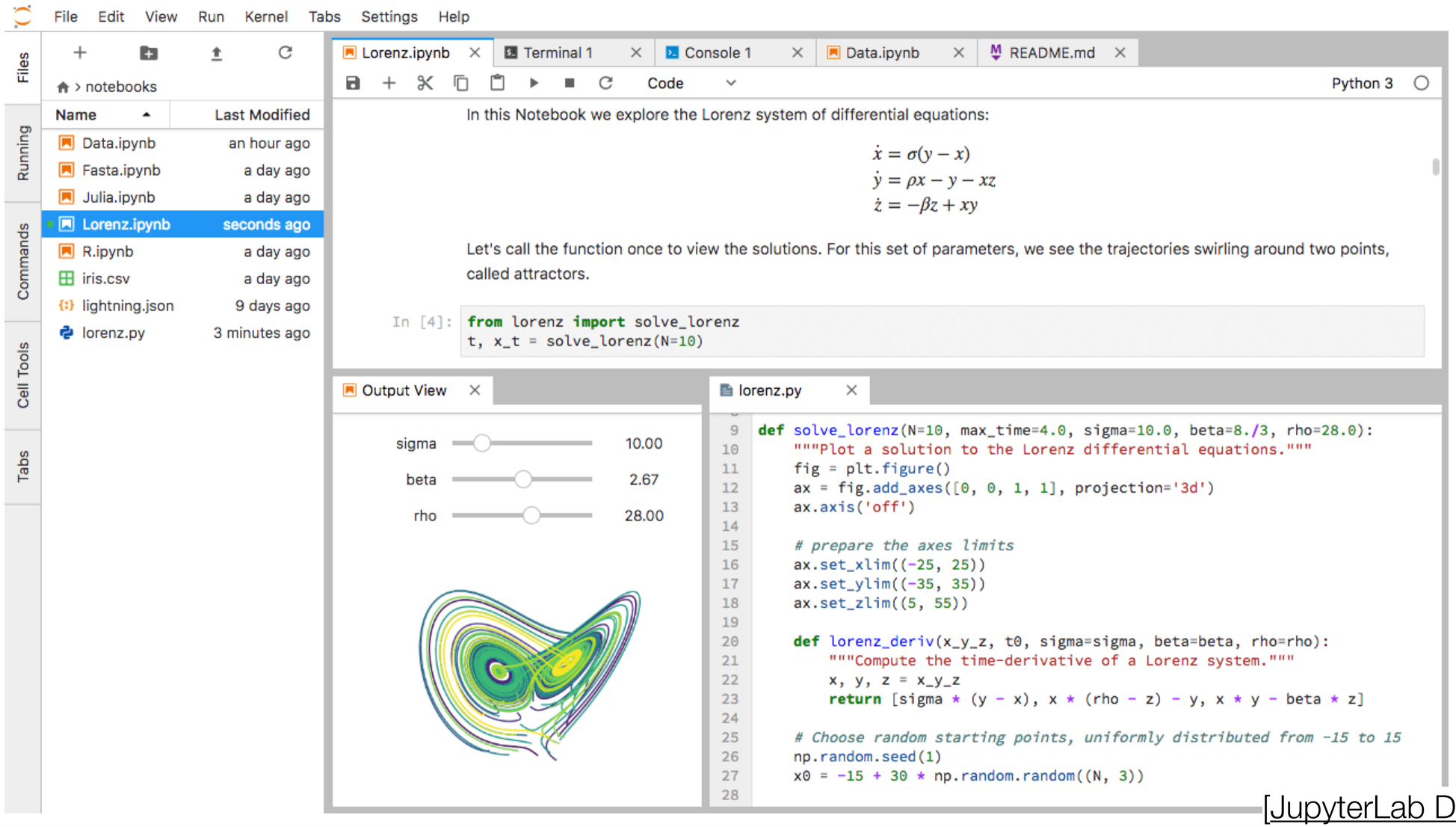
- Python is **interpreted**: you can run one line at a time without compiling
- Interpreter in the Shell
  - Execute line by line
  - Hard to structure loops
  - Usually execute whole files (called scripts) and edit those files
- Notebook
  - Richer results (e.g. images, tables)
  - Can more easily edit past code
  - Re-execute any cell, whenever

Python Differences

- Dynamic Typing
  - A variable does not have a fixed type
  - Example: `a = 1; a = "abc"`
- Indentation
  - Braces define blocks in Java, good style is to indent but not required
  - Indentation is critical in Python

```
z = 20
if x > 0:
    if y > 0:
        z = 100
else:
    z = 10
```

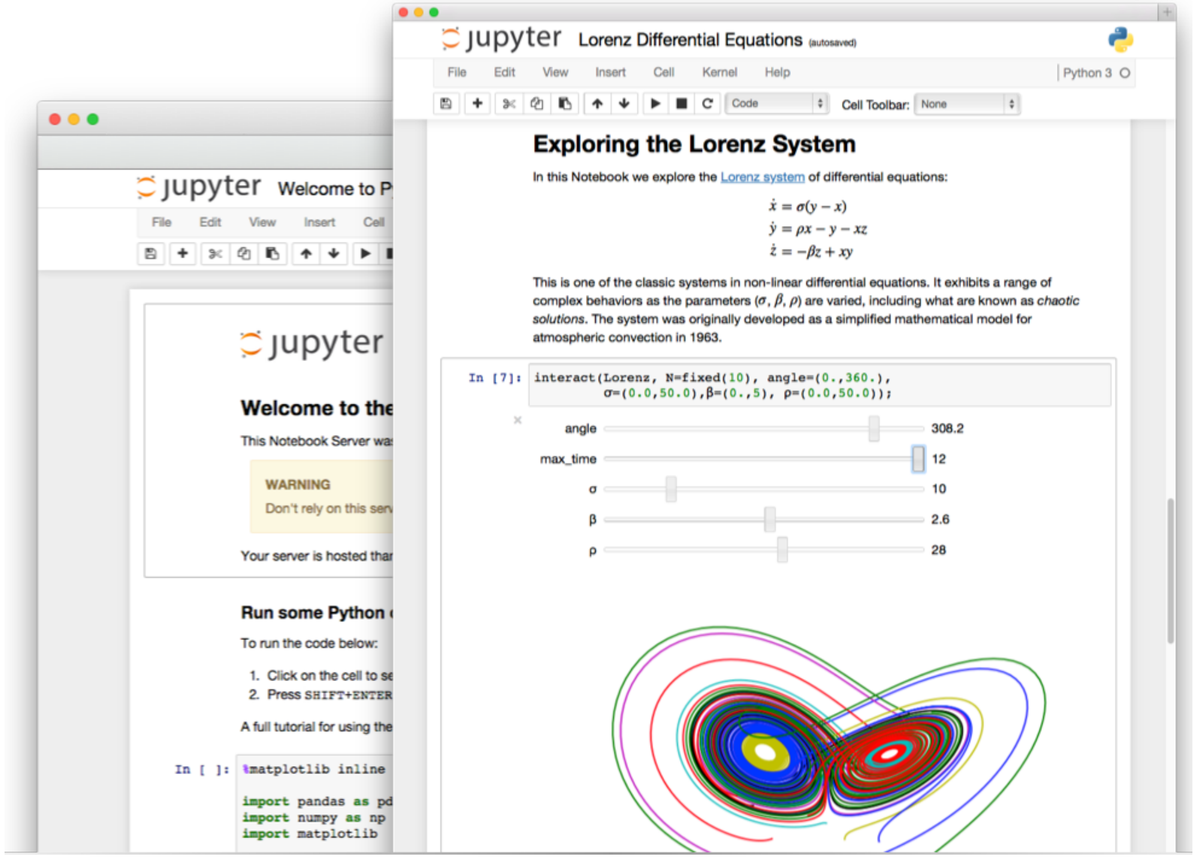
JupyterLab and Jupyter Notebooks



[JupyterLab Documentation]

Jupyter Notebooks

- Display rich representations and text
- Uses Web technology
- Cell-based
- Built-in editor
- GitHub displays notebooks



[Jupyter]

Jupyter Notebooks

- An interactive programming environment
- Runs in your web browser
- Displays results (even interactive maps) inline
- Originally designed for Python
- Supports other languages, too
- You decide how to divide code into executable cells
- Shift+Enter (or the "play" button) to execute a cell

JupyterLab Notebooks

- Starts with a directory view
- Create new notebooks using the Launcher (+ icon on the left)
  - New notebooks have the name "Untitled"
  - File → Rename Notebook… (or right-click) to change the name
- Save a notebook using the command under the File menu
- Shutting down the notebook requires quitting the kernel
  - Web browser is **interface** to display code and results
  - **Kernel** runs the code: may see messages in a console/terminal window
  - Closing the browser window does not stop Jupyter
  - Use File → Hub Control Panel → Stop My Server to reset on tiger

JupyterLab Notebooks

- Open a notebook using the left panel like you would in a desktop view
- Past results are displayed—does not mean they are loaded in memory
- Use "Run All" or "Run All Above" to re-execute past work
  - If you shut down the kernel, all of the data and variables you defined need to be redefined (so you need to re-run all)
  - **Watch Out—Order Matters**: If you went back and re-executed cells in a different order than they are shown, doing "Run All" may not produce the same results!
- Edit mode (green) versus Command mode (blue == **Be Careful**)

JupyterLab Notebooks

- Can write code or plain text (can be styled Markdown)
  - Choose the type of cell using the dropdown menu
- Cells break up your code, but all data is **global**
  - Defining a variable `a` in one cell means it is available in **any** other cell
  - This includes cells **above** the cell `a` was defined in!
- Remember **Shift+Enter** to execute
- Enter just adds a new line
- Use `?<function_name>` for help
- Use Tab for **auto-complete** or suggestions
- Tab also indents, and Shift+Tab unindents